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## Original Study

## Comprehensive Geriatric Hospital at Home: Adaptation to Referral and Case-Mix Changes During the COVID-19 Pandemic



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## A B S T R A C T

## Keywords:

Hospital at home  
aging  
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**Objectives:** To describe the evolution of a Hospital at Home (HAH) based on comprehensive geriatric assessment (CGA), including its adaptability to changing case-mixes and pathways during the COVID-19 pandemic.

**Design:** Observational study of consecutive admissions to a combined step-up (admissions from home) and step-down (hospital discharge) HAH during 3 periods: pre-pandemic (2018–February 2020) vs pandemic (March–December 2020, and January–December 2021).

**Setting and Participants:** Participants were all consecutive patients admitted to a CGA-based HAH, located in Barcelona, Spain. Referrals followed acute events or exacerbation of chronic conditions, by either primary care (step-up) or after post-acute discharge (step-down).

**Methods:** HAH intervention based on CGA and incorporated geriatric rehabilitation. Patient case-mix, functional evolution (Barthel index), and mortality were compared across periods and between pathways.

**Results:** HAH capacity expanded 3 fold from 15 to 45 virtual beds and altogether managed 688 consecutive patients [mean age (SD) = 82.5 (9.6) years; 59% women]. Pandemic case-mix was slightly older (mean age = 83.5 vs 82 years,  $P = .012$ ) than pre-pandemic, with greater mobility impairment. Across periods, step-up increased (26.1%, 40.9%, 48.2%,  $P < .01$ ) because of medical events, skin ulcers, and post-acute stroke, whereas step-down decreased; multivariable models showed no differences in functional improvement or mortality. When comparing pathways, step-up featured older patients with higher comorbidity, worse functional status, and lower absolute functional gain than step-down (5.6 vs 13 points of Barthel index,  $P < .01$ ), remaining statistically significant after adjusting for covariates ( $P = .003$ ); no differences in mortality were observed.

**Conclusions and Implications:** A multipurpose, step-down and step-up CGA HAH expanded its activity and adapted to changing case-mixes and pathways throughout COVID-19 pandemic waves. Although further quantitative and qualitative studies are needed to assess the impact of this model, our results suggest that harnessing the adaptability of HAH may help advance a paradigm shift toward more person-centered, cost-effective models of clinical care aimed at older adults.

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Western countries face population aging, associated with progressively increasing disability and complex health and social care needs. In this scenario, the classic “reactive” health care model, based on urgent assessment and resolution in the acute hospital, needs to evolve toward proactive and community-based integrated health and

social care.<sup>1</sup> Many older adults prefer to receive care and support at home, if safe and appropriate.<sup>2</sup> Hospital at home (HAH) has emerged as a safe, effective, and high-quality alternative to conventional inpatient care. It has been implemented in different populations: oncology, postsurgery or trauma, or decompensation of chronic diseases. To access HAH, patient clinical conditions should be sufficiently stable to allow management at home with support from the family and/or informal caregivers.<sup>3</sup> Patient<sup>4</sup> and caregiver<sup>5</sup> experiences with HAH is highly positive.

HAH may substitute an episode of inpatient care (“step-up” or admission avoidance pathway) or may enable an early supported discharge from the hospital (“step-down”) to continue medical treatments or rehabilitation. In older adults, step-up HAH has shown comparable efficiency to conventional hospitalization, with improved delirium outcomes and a delay in institutionalization.<sup>6</sup> Likewise, step-down models of care have proven effective in older populations.<sup>7</sup> We have previously shown that an interdisciplinary HAH team that applies a comprehensive geriatric assessment (CGA) approach for older adults can offer combined step-up and step-down pathways tailored to the needs of patients, carers, and local systems.<sup>8,9</sup> This interdisciplinary CGA-based model overlaps with a broader suite of intermediate care services that operate at the interface between hospital and primary care.<sup>10</sup>

The onset of the COVID-19 pandemic heightened awareness of the urgent need for innovative community-based solutions.<sup>11</sup> Increased demand from coronavirus illness, exacerbations of chronic conditions, and widespread deconditioning have been overwhelming the capacity of primary care and hospitals.<sup>12–14</sup> The risk of COVID-19 transmission was lower for care at home than in hospital or long-term care facilities. Both issues prompted technology-enabled models of HAH for patients with COVID-19.<sup>15</sup>

The rapid expansion and adaptation of the HAH model to the changing pandemic context has been challenging, and evidence on its performance in this scenario, besides the specific care for COVID-19 patients, is limited. Therefore, this observational study aims to describe the influence of the pandemic on referral patterns, case-mix, and outcomes of an urban interdisciplinary HAH based on comprehensive geriatric assessment and management (CGA HAH), progressively expanded during sequential waves of the COVID-19 pandemic.

## Methods

### Design

Study design featured a cohort of patients admitted to a combined step-up and step-down HAH during 3 consecutive periods: period 1 (“Prepandemic”), between January 2018 (date of implementation of the first HAH team) and February 2020; period 2 (“Pandemic 2020”), between March 2020 (the official declaration of the COVID-19 pandemic in Spain) and December 2020, including the first lockdown phase (March–May 2020); period 3 (“Pandemic 2021”), between January and December 2021, during 2 subsequent waves. For the present analysis, we compared patient outcomes across successive periods and between the step-up and step-down pathways. In line with the Declaration of Helsinki of 1975, prior to the start of the study, its protocol was approved by the corresponding ethics committee, and written informed consent was obtained from all participants to be managed by the CGA HAH team.

### Population

Older adults (65 years and older) referred to CGA based HAH following: (1) an acute event (eg, hip fracture, stroke, COVID-19 infection or surgery); (2) an exacerbation of a chronic condition (eg, heart failure or chronic obstructive pulmonary disease) or (3) an

infection superimposed on a complex chronic condition such as dementia or complex multimorbidity.

### The CGA HAH model

The HAH of Parc Sanitari Pere Virgili (PSPV) is part of an extensive intermediate care service network coordinated by the PSPV Hospital, which serves as the reference hub for intermediate care for approximately 900,000 citizens in the Barcelona metropolitan area of Catalonia, Spain. The network also comprises 365 intermediate care hospital beds (providing geriatric rehabilitation, subacute, long-term, and palliative care), ambulatory services (geriatric day hospital, dementia, and geriatric outpatients, frailty management unit in the community), and 2 palliative home-care teams. In addition, the 2 local university hospitals also provide an acute HAH service, albeit this is not specialized for older adults, and does not provide rehabilitation.

At PSPV, a first CGA HAH team was implemented in January 2018, a second team in January 2021, and a third one in October 2021. The interdisciplinary and CGA-based functioning of the teams, as well as their governance and coordination within the local system, is detailed in Table 1. Each team manages approximately 15 patients in their own homes as a “virtual ward,” so by October 2021, the overall caseload had expanded to 45 patients. To be eligible for HAH, patients need to be hemodynamically stable and have a caregiver at home who can support the tailored plan established by HAH teams. Reimbursement of expenses is 100% public, and the reference length of stay is around 4–6 weeks.

### Outcomes

Functional status is routinely assessed with the Barthel index<sup>16</sup> (0–100, total to no disability in the activities of daily living) at admission and discharge. Baseline value is retrieved from patients and proxies. Primary outcomes were functional improvement (change in Barthel index between HAH admission and discharge) and mortality during the HAH episode.

### Covariates

Covariates include sociodemographic data (age, sex, living situation, formal caregiver), comorbidities (including the Charlson index<sup>17</sup>), diagnosis at admission and geriatric syndromes, including nutritional assessment (Confusion Assessment Method, CAM<sup>18</sup>) through Mini-Nutritional Assessment–Short Form,<sup>19</sup> depressive symptoms (Geriatric Depression Scale),<sup>20</sup> delirium screening (CAM), sleep disturbances, walking impairment, falls in the previous 6 months, dysphagia, sensory deficits, urinary incontinence, constipation, and polypharmacy (5+ drugs).

### Statistical Analyses

Characteristics of the sample are presented as mean values and standard deviation (SD) for continuous variables and absolute numbers plus percentages for categorical variables. Characteristics and outcomes of patients admitted in the different periods were compared using the ANOVA or Kruskal–Wallis test and  $\chi^2$  test. Differences between the 2 main care pathways (step-down and step-up) were analyzed using the  $\chi^2$  test for proportions and the t Student test or the Mann–Whitney test for continuous variables.

Variables showing a significant difference between groups (*P*-for-trend value of <.05) and those considered clinically relevant, or to have a potential influence on the outcomes, were included in a multivariable linear or logistic regression models to determine the adjusted effect of the pandemic period and of the care pathway on functional improvement and mortality, respectively.

**Table 1**  
Description of the HAH Model According to Predefined Descriptive Categories

Admission Avoidance HAH with CGA	
Organizational features	
Team members	Geriatrician, nurse, physiotherapist, occupational therapist, 0.5 whole time equivalent social worker, speech therapist (online), for each 15 beds.
Responsibility	Attending geriatricians and specialized nurses.
Governance structure	Under the structure of Parc Sanitari Pere Virgili intermediate care hospital (department of ambulatory and home-care geriatrics).
Patient referral route to CGA HAH	<ul style="list-style-type: none"> <li>• Acute hospital, from the emergency department or acute wards.</li> <li>• Subacute care unit at the intermediate care hospital.</li> <li>• Primary care (family medicine or nursing).</li> </ul>
Patient assessment when admitted to CGA HAH	All the referrals must include clinical and social information. (1) Patients admitted from an acute hospital are assessed, before admission, by a reference professional, in some cases by a geriatric nurse performing a systematic short CGA. The nurse practitioner at the HAH collects information, contacts the referring staff by phone within 12 to 24 h of referral, and discusses with a geriatrician and social worker who assesses them at home after admission.(2) Patients admitted from home are assessed by a geriatrician, a specialized nurse, and a social worker within 24 to 48 h.
Comprehensive geriatric assessment (CGA)	<p>A specialized nurse completes the initial assessment, followed by a medical assessment (&lt;24 h after admission). Elements include</p> <ul style="list-style-type: none"> <li>• Clinical history and examination; list of differential diagnoses.</li> <li>• Assessment of medical, functional, and cognitive needs in the home environment on the day of admission, which includes screening for delirium, geriatric syndromes, dementia and depression, assessment of frailty, skin, nutrition, vision, hearing.</li> <li>• Review of investigations and medication review.</li> <li>• Socioeconomic status, risk assessment and home environment.</li> <li>• Multidimensional CGA-based individualized treatment plan.</li> <li>• Communication with patients (or representatives) and caregivers for shared goals, decision-making and advanced care planning.</li> </ul>
Virtual ward or board rounds	In-person care is available from 8 am to 9pm. Home visits by all team members are planned depending on individual needs. Daily visits by at least 1 team member (Monday to Friday). Each patient's evolution, intervention plan and discharge planning are discussed in the weekly interdisciplinary board meeting.
Out-of-hours care	9 pm to 8 am is covered by the physician on call in hospital, providing telephone advice or activating the emergency services.
Specific roles of team members and partners	
Geriatrician and specialty training doctors	Clinical governance, clinical review, trainee supervision, communication with the primary care team, investigations orders, drug prescription, and referrals to other specialties.
Specialized nurses	<ul style="list-style-type: none"> <li>• Patient assessment at home, including activities of daily living, delirium, physical or cognitive ability, and falls.</li> <li>• Provision of equipment and medication</li> <li>• Investigations requests, extraction of blood samples.</li> <li>• ECG, urinary catheterization, dressings to skin lesions.</li> <li>• IV fluids and drugs administration.</li> <li>• Link with community teams for follow-up care.</li> <li>• Predischage visits in the hospital to build trust with patients.</li> </ul>
Physiotherapists and occupational therapists	<ul style="list-style-type: none"> <li>• Functional assessment to include gait, balance, managing stairs, chest physiotherapy, exercise program, and walking aids.</li> <li>• Assessment and training in the activities of daily living also outside the house; equipment provision and training.</li> </ul>
Social workers	<ul style="list-style-type: none"> <li>• Social and family assessment and detection of needs.</li> <li>• Guidance on procedures and social resources.</li> <li>• Coordination with external services (ie, primary care social worker, social services) and referral to them if necessary.</li> <li>• Drafting of the social report upon discharge.</li> </ul>
Pharmacists	<ul style="list-style-type: none"> <li>• Medicine reconciliation, polypharmacy, and adherence checks.</li> </ul>
Primary care physicians and teams	<ul style="list-style-type: none"> <li>• Triage referrals for CGA HAH in case of step-up pathway</li> <li>• Cooperates during the process if particular issues arise</li> <li>• Receive discharge information through Shared Health Electronic platform of Catalonia and assume care continuity</li> </ul>

ECG, electrocardiogram.

All analyses were performed using Stata v 14 (StataCorp LLC).

## Results

Between 2018 and 2021, the CGA HAH managed 688 consecutive patients (mean age = 82.5 years; SD = 9.6 years, 59% women), mainly referred by acute hospitals (49%), followed by primary care (37%). Overall, 85.5% lived with family members, and 31% were already assisted by a formal caregiver (Table 2). The mean Charlson index was 2.2, indicating moderate comorbidity, and patients were frankly disabled in the basic activities of daily living (mean Barthel index 53.2 at admission) from a pre-event state of mild-moderate disability. After a decrease during the pandemic 2020 period, the number of

admissions increased in the pandemic 2021 period, with the expansion of HAH capacity (Figure 1).

Compared with the prepandemic period, patients admitted during the pandemic were slightly older and had greater mobility impairment but a reduced history of falls and lower rates of delirium. The proportion of patients referred directly by primary care teams (step-up pathway) increased progressively during the pandemic (Table 2). Over time, there was a significant shift in the principal reasons for HAH: a decrease in “surgical profile” (general and orthopedic), while medical events, care of pressure and vascular ulcers, and post-acute stroke increased. The team also attended a small number of acute patients with COVID-19. There was no change in the pattern of comorbidities over time. Episodes of delirium preceding the

**Table 2**  
Baseline Characteristics of Patients Admitted to the CGA HAH, Comparing Prepandemic and Pandemic Periods

	Total, N = 688	Prepandemic, n = 307	Pandemic 2020, n = 159	Pandemic 2021, n = 222	P Value
Age, mean (SD)	82.5 (9.6)	82.0 (8.8)	81.9 (10.2)	83.5 (10.2)	.012
Women, % (n)	58.6 (391)	55.7 (171)	56.6 (90)	58.6 (130)	.517
Living situation, % (n)					.664
Living with family	85.5 (588)	85.0 (261)	88.7 (141)	83.8 (186)	
Living with a caregiver	10.6 (73)	10.8 (33)	8.2 (13)	12.2 (27)	
Nursing home	3.9 (27)	4.2 (13)	3.1 (5)	4.1 (9)	
Formal caregiver, % (n)	31.5 (216)	31.2 (95)	27.2 (43)	35.1 (78)	.386
Source of referral, % (n)					<.001
Primary care teams	36.6 (252)	26.1 (80)	40.9 (65)	48.2 (107)	
Intermediate Care beds	14.1 (97)	14.0 (43)	15.7 (25)	13.1 (29)	
Acute Hospitals	49.3 (339)	59.9 (184)	43.4 (69)	38.7 (86)	
Comorbidities, % (n)					
Cardiovascular*	83.9 (577)	84.4 (259)	83.0 (132)	83.8 (186)	.838
Diabetes mellitus	30.9 (212)	30.9 (95)	35.9 (57)	27.3 (60)	.402
Cerebrovascular	20.1 (138)	15.6 (48)	18.2 (29)	27.5 (61)	.001
Chronic Renal Failure	29.2 (201)	29.0 (89)	30.2 (48)	28.8 (64)	.987
Dementia or Cognitive impairment	28.2 (194)	29.6 (91)	25.8 (41)	27.9 (62)	.624
Depression	19.6 (135)	18.9 (58)	20.1 (32)	20.3 (45)	.684
COPD	19.3 (133)	22.2 (68)	18.9 (30)	15.8 (35)	.066
Neoplasia	13.5 (93)	11.7 (36)	16.3 (26)	14.0 (31)	.405
Charlson index, mean (SD)	2.2 (1.8)	2.0 (1.7)	2.5 (2.1)	2.2 (1.8)	.068
Diagnosis at admission, % (n)					
Post-surgery	1.7 (12)	3.6 (11)	0.6 (1)	1.0 (0)	.001
Orthogeriatric	33.4 (230)	41.3 (127)	28.9 (46)	25.7 (57)	<.001
Medical event†	50.4 (347)	47.6 (146)	57.2 (91)	49.6 (110)	.546
Stroke	6.0 (41)	2.9 (9)	6.9 (11)	9.5 (21)	.002
Skin ulcers	5.5 (38)	4.6 (14)	3.8 (6)	8.1 (18)	.095
COVID-19	2.9 (20)	0.0 (0)	2.5 (4)	7.2 (16)	<.001
Geriatric syndromes, % (n)					
Delirium (acute episode)	14.5 (100)	21.5 (66)	9.4 (15)	8.5 (19)	<.001
Sleep disturbances	25.2 (173)	24.1 (74)	21.4 (34)	29.3 (65)	.211
Walking impairment	39.7 (273)	21.2 (65)	54.7 (87)	54.5 (121)	<.001
Falls (past 6 mo)	55.8 (363)	65.3 (186)	46.4 (71)	49.8 (106)	<.001
Polypharmacy‡	62.4 (429)	65.8 (202)	61.0 (97)	58.6 (130)	.085
Dysphagia	14.4 (99)	12.4 (38)	13.8 (22)	17.6 (39)	.098
Malnutrition	8.6 (59)	9.5 (29)	8.8 (14)	7.2 (16)	.371
Sensory deficits§	46.7 (321)	49.8 (153)	46.5 (74)	42.3 (94)	.089
Urinary incontinence	50.4 (347)	50.8 (156)	42.8 (68)	55.4 (123)	.386
Constipation	29.8 (205)	25.4 (78)	30.8 (49)	35.1 (78)	.015
Functional assessment, mean (SD)					
Barthel index, pre-admission	76.4 (24.9)	77.4 (23.4)	77.1 (25.9)	74.6 (26.2)	.532
Barthel index, admission	53.2 (23.5)	52.7 (22.0)	54.8 (24.7)	52.8 (24.7)	.788

NOTE. Bold values are statistically significant ( $P < .05$ ).

COPD, chronic obstructive pulmonary disease.

\*Cardiovascular disease: Hypertension, ischemic cardiomyopathy, atrial fibrillation, chronic heart disease.

†Medical event: decompensation of chronic diseases such as heart failure, chronic pulmonary disease, chronic renal failure, dehydration, pain control.

‡Polypharmacy:  $\geq 5$  drugs.

§Sensory deficits: auditory or visual deficits.

admission and falls lowered over time, whereas walking impairment and constipation increased. The length of stay increased progressively [mean (SD), days = 33.0 (19.3) vs 36.3 (24.3) vs 38.9 (21.5),  $P$ -for-trend = .018], and there was no statistically significant difference in readmissions to the acute hospital [mean (SD) = 15.0 (46) vs 10.1 (16) vs 14.4 (32) across groups,  $P$ -for-trend = .760]. Absolute improvements in Barthel index were not different across the 3 waves [mean (SD) = 11.1 (14.5), 9.6 (12.9), 9.9 (13.7), respectively,  $P$ -for-trend = .266], whereas there was a statistically significant increase in absolute deaths [2.6(8), 6.3 (10), 7.2 (16), respectively,  $P$ -for-trend = .037]. However, in the adjusted models there were no differences in functional improvement or mortality across the periods (Table 3).

Patients referred by primary care (step-up) were older, with a higher prevalence of comorbidities (cardiovascular disease, dementia, chronic obstructive pulmonary disease) and a worse functional status pre-episode (Supplementary Table 1). When comparing step-up and step-down in the whole HAH sample, the step-up pathway showed a significantly lower functional improvement [Barthel index, mean (SD) 5.6 (13.5) vs 13.0 (13.4),  $P \leq .001$ ] and an increased mortality [9.9 (25) vs 2.0 (9),  $P < .001$ ]. In adjusted models (Table 4), functional

improvement remained significantly lower for the step-up group, whereas the difference was not significant for mortality.

## Discussion

In our experience, after a temporary reduction of referral (mainly because of step-down demand, as hospital activity shifted toward COVID-19), the HAH had expanded by 2021 to 3 teams to meet the increased demand. This was partially driven by an increased referral from primary care, with a corresponding shift in case-mix. Outcomes did not change across pandemic periods, although the step-up group had significantly lower functional improvement than the step-down one, partly attributable to differences in case-mix.

The reduction in step-down demand, previously the main source of referrals, is primarily explained by the shift of activity in acute care hospitals.<sup>12,13</sup> The subsequent increase in step-up demand is likely due to the need for alternative solutions for older adults with exacerbations of chronic diseases, when primary care was focused on managing community-dwelling patients with COVID-19 and contact tracing, with a reduced follow-up of patients



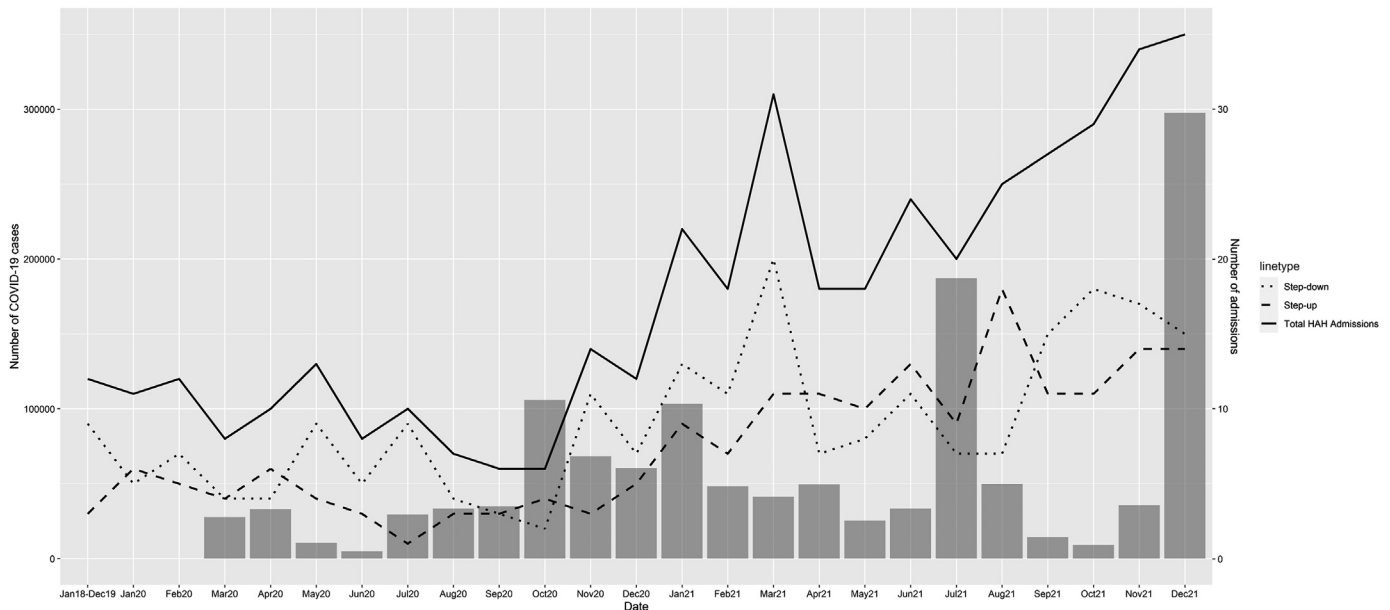


Fig. 1. Number of admissions to CGA HAH by month and number of confirmed COVID-19 cases in Catalonia.

with chronic multimorbidity.<sup>14</sup> Our HAH model integrates a rehabilitative function, in line with the integrated transitional and intermediate care model for older adults,<sup>10</sup> which enhances the care continuum and also explains the different length of stay, compared with the acute HAH literature. Notably, although many rehabilitation activities were temporarily interrupted at the beginning of the pandemic all over the world,<sup>21</sup> including in Catalonia, this CGA HAH remained active, as social distancing was feasible in the patient environment within the pandemic scenario.

At an international level, there is a growing interest in HAH research.<sup>22</sup> Systematic reviews suggest that both care pathways have similar or improved outcomes compared with conventional hospitalization.<sup>23</sup> We had previously shown, in a different population, that

this CGA HAH model, combining step-up and step-down care within the same team, was comparable with conventional hospitalization for both care pathways,<sup>8,9</sup> also for specific processes such as stroke rehabilitation,<sup>24</sup> with a contextual reduction of the length of stay.<sup>8,25</sup> In a recent large United Kingdom trial on step-up HAH, the authors found comparable outcomes in living at home and mortality at 6 months. Older adults were more satisfied with the HAH care, less often experienced delirium, and fewer were admitted to nursing homes.<sup>6</sup> Care at home is a valuable resource for managing geriatric syndromes such as delirium.<sup>26</sup>

**Table 3**  
Multivariable Regression models, Comparing the Main Outcomes (Functional Improvement and Death) Across the Prepandemic and Pandemic Periods

Regression Models	Barthel Index Improvement			Death		
	Linear Regression			Logistic Regression		
	$\beta$	95% CI	P Value	OR	95% CI	P Value
Unadjusted						
Prepandemic	ref					
Pandemic 2020	-1.17	-4.20 ; 1.86	.448	2.51	0.97 ; 6.49	.058
Pandemic 2021	-1.19	-3.97 ; 1.56	.395	2.90	1.22 ; 6.91	<b>.016</b>
Adjusted						
Prepandemic	ref					
Pandemic 2020	-1.21	-4.38 ; 1.95	.451	2.03	0.62 ; 6.68	.239
Pandemic 2021	-0.94	-3.93 ; 2.03	.534	2.26	0.75 ; 6.85	.149
Age	-0.09	-0.22 ; 0.04	.158	1.08	1.02 ; 1.14	<b>.013</b>
Female	4.01	1.61 ; 6.40	<b>.001</b>	0.86	0.38 ; 1.93	.707
Referral from primary care	-6.10	-8.71 ; -3.50	<b>&lt;.001</b>	2.98	1.21 ; 7.32	<b>.017</b>
Stroke*	6.24	1.61 ; 10.94	<b>.009</b>	1 (omitted)		
Previous walking impairment	1.40	-1.14 ; 3.95	.278	1.91	0.85 ; 4.29	.119
Delirium (acute episode)	-3.63	-6.86 ; -0.40	<b>.028</b>	0.83	0.23 ; 3.04	.790
Falls (past 6 mo)	2.41	-0.11 ; 4.94	.061	0.54	0.23 ; 1.25	.149

NOTE. Bold values are statistically significant ( $P < .05$ ).

Barthel index improvement: Barthel index at discharge minus Barthel index at admission.

\*Main diagnosis at admission.

**Table 4**  
Multivariable Regression Models Comparing the Main Outcomes (Functional Improvement and Death) Between Step-Up and Step-Down Pathway

Regression Models	Barthel Improvement			Death		
	Linear Regression			Logistic Regression		
	$\beta$	95% CI	P Value	OR	95% CI	P Value
Unadjusted						
Step-up	ref					
Step-down	7.45	5.03 ; 9.86	<b>&lt;.001</b>	0.19	0.09 ; 0.42	<b>&lt;.001</b>
Adjusted						
Step-up	ref			ref		
Step-down	4.12	1.44 ; 6.82	<b>.003</b>	0.46	0.18 ; 1.15	.098
Age	-0.05	-0.19 ; 0.08	.452	1.07	1.00 ; 1.13	<b>.036</b>
Female	2.99	0.54 ; 5.43	<b>.017</b>	0.99	0.42 ; 2.34	.987
Formal caregiver	-1.67	-4.37 ; 1.04	.226	0.88	0.38 ; 2.04	.759
Cardiovascular disease*†	-1.52	-4.68 ; 1.63	.343	1.53	0.33 ; 7.11	.585
Dementia or cognitive impairment†	1.84	-4.59 ; 0.91	.189	0.80	0.32 ; 1.98	.625
Orthogeriatric‡	4.45	0.167 ; 7.24	<b>.002</b>	0.28	0.06 ; 1.37	.116
Falls (past 6 mo)	1.09	-1.43 ; 3.60	.397	0.78	0.33 ; 1.82	.561
Barthel pre-admission	0.05	0.01 ; 0.111	<b>.046</b>	0.98	0.97 ; 0.99	<b>.028</b>

NOTE. Bold values are statistically significant ( $P < .05$ ).

Barthel index improvement: Barthel index at discharge minus Barthel index at admission.

\*Cardiovascular disease: Hypertension, ischemic cardiopathy, atrial fibrillation, chronic heart disease.

†Comorbidities.

‡Main diagnosis at admission.

Patients referred during the pandemic were slightly older and showed more mobility impairment than prepandemic HAH patients, to which the lack of physical activity associated with social distancing measures might have contributed.<sup>27</sup> The lower risk of delirium could be due to lower rates of hospitalization, a significant risk factor for delirium,<sup>28</sup> and perhaps less confidence in diagnosing delirium in primary care/home settings.

Functional impairment and mortality were not substantially different comparing the pandemic and prepandemic groups overall but functional improvement was lower for step-up HAH cases. These patients were generally complex with a considerably higher prevalence of cardiovascular, dementia, and cancer comorbidities that contribute to poor outcomes. We speculate that primary care physicians may preferentially refer such patients to HAH given the low benefit/risk ratio associated with conventional hospital care. However, they may also have delayed the referral because they are less aware of this care option. The observed unadjusted difference in mortality between step-up and step-down pathways is consistent with other studies<sup>29</sup> and probably related with the higher age and comorbidity burden of patients in the step-up pathway. A few studies have investigated the impact of HAH models on the functional status of older adults: in general, results seem favorable<sup>30</sup> compared with conventional acute care, with reduced use of subsequent rehabilitation services<sup>31</sup>; functional outcomes appear at least not inferior to geriatric rehabilitation or bed-based intermediate care.<sup>8</sup> It has been suggested that HAH models might favor patient daily physical activity, although research in this field is scarce.<sup>32</sup>

HAH is viable for hemodynamically stable patients who do not need intensive diagnostic or treatment resources and have a caregiver who can assume responsibility for some care tasks.<sup>3</sup> Unless integrated health and social care systems are strengthened, the need for an informal caregiver might be an important limitation to scale up HAH. Increasing international evidence supports the cost-effectiveness of CGA HAH, compared to conventional hospitalization,<sup>33</sup> also considering the 30-day post-acute care period.<sup>34</sup>

This study has different limitations. First, it is difficult to assess generalizability of results because local contextual factors and relationships with primary care and after-hour providers may have influenced the HAH process and outcomes. Second, the 3 time periods studied might be considered arbitrary, although they were chosen to balance the need to differentiate between periods with different operational context with need to maintain a reasonable sample size in each group. Finally, we could not control for the severity/acuity of the disease at admission. Study strengths include the real-life implementation-research approach, the relatively large sample size for an innovative model of care, and careful and complete data collection across both the acute and rehabilitation phases of the intervention.

## Conclusions and Implications

In conclusion, the COVID-19 pandemic has been an important catalyst in strengthening this innovative alternative model of care. Our CGA HAH teams showed an ability to rapidly adapt and evolve the service in response to the different pandemic waves, maintaining flexibility to manage changing case-mixes between the 2 pathways. Despite managing more complex and functionally impaired patients over time, the outcomes of HAH did not worsen significantly. CGA HAH represents a powerful evolution of traditional geriatric care and a valuable alternative to conventional hospitalization for health care systems. We advocate further empirical research of this model in different systems and with an evaluation of outcomes against the quadruple aim (health outcomes, patients and caregiver experience, experience of professionals, and costs), as harnessing the adaptability of CGA HAH may help advance a paradigm shift toward more person-centered, cost-effective models of clinical care aimed at older adults.

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**Supplementary Table 1**

Baseline Characteristics of Patients Included in Geriatric HAH Comparing Types of Care Pathway

	Total, N = 688	Step-up, n = 307	Step-down, n = 351	P Value
Age, mean (SD)	82.7 (9.2)	85.0 (8.3)	81.0 (10.0)	<.001
Female, % (n)	56.5 (372)	58.7 (148)	55.7 (243)	.445
Social situation				
Living with				.193
Family	85.2 (561)	82.9 (209)	86.9 (379)	
Caregiver	10.8 (71)	11.5 (29)	10.1 (44)	
Nursing home	4.0 (26)	5.6 (14)	3.0 (13)	
Formal caregiver, % (n)	32.4 (212)	40.6 (102)	26.3 (114)	<.001
Comorbidities				
Cardiovascular,* % (n)	83.9 (552)	88.1 (222)	81.4 (355)	.022
Diabetes mellitus, % (n)	31.0 (204)	27.8 (70)	32.6 (142)	.190
Cerebrovascular, % (n)	20.1 (132)	18.7 (47)	20.9 (91)	.483
Chronic renal failure, % (n)	28.9 (190)	32.5 (82)	27.3 (119)	.145
Dementia or cognitive impairment, % (n)	28.4 (187)	34.5 (86)	24.8 (108)	.009
Depression, % (n)	19.2 (126)	17.5 (44)	20.9 (91)	.278
COPD, % (n)	19.9 (131)	24.6 (62)	16.3 (71)	.008
Neoplasia, % (n)	13.5 (89)	11.5 (29)	14.7 (64)	.241
Charlson index, mean (SD)	2.2 (1.8)	2.2 (1.6)	2.2 (1.9)	.985
Diagnosis at admission, % (n)				
Postsurgery	1.8 (12)	0.8 (2)	2.3 (10)	.148
Orthogeriatric	32.2 (212)	13.5 (34)	45.0 (196)	<.001
Medical event†	51.5 (339)	70.6 (178)	38.8 (169)	<.001
Stroke	6.1 (40)	4.4 (11)	6.9 (30)	.179
Pressure/vascular ulcers	5.5 (36)	9.9 (25)	3.0 (13)	<.001
COVID-19/post-COVID-19	2.9 (19)	0.8 (2)	4.1 (18)	.012
Geriatric syndromes, % (n)				
Delirium (acute episode)	14.5 (100)	12.3 (31)	15.8 (69)	.206
Sleep disturbances	25.2 (173)	25.8 (65)	24.8 (108)	.766
Walking impairment	39.7 (273)	39.3 (99)	39.9 (174)	.872
Falls (past 6 mo)	55.8 (363)	41.5 (95)	63.5 (268)	<.001
Polypharmacy‡	62.4 (429)	61.1 (154)	63.1 (275)	.609
Dysphagia	14.4 (99)	17.1 (43)	12.8 (56)	.129
Malnutrition	8.6 (59)	7.1 (18)	9.4 (41)	.308
Sensory deficits§	46.7 (321)	54.0 (136)	42.4 (185)	.003
Urinary incontinence	50.4 (347)	57.1 (144)	46.6 (203)	.007
Constipation	29.8 (205)	31.8 (80)	28.7 (125)	.395
Functional assessment, mean (SD)				
Barthel index pre-admission	76.4 (24.9)	67.7 (27.8)	81.3 (21.6)	<.001
Barthel index (admission)	53.2 (23.5)	51.7 (25.9)	54.0 (21.9)	.230

NOTE. Bold values are statistically significant ( $P < .05$ ).

COPD, chronic obstructive pulmonary disease.

\*Cardiovascular disease: Hypertension, ischemic cardiopathy, atrial fibrillation, chronic heart disease.

†Medical event: decompensation of chronic diseases as heart failure, chronic pulmonary disease, chronic renal failure, dehydration, pain control.

‡Polypharmacy:  $\geq 5$  drugs.

§Sensory deficits: auditory or visual deficits.